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HEAT DISSIPATION ARRANGEMNTS

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(54) HEAT DISSIPATION ARRANGEMENTS

(71) We, REDPOINT ASSOCIATES LIMITED, a British Company, of Lynton Road, Cheney Manor, Swindon, SN2 2QN Wiltshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to arrangements for cooling heat sources, and in particular the invention is concerned with the cooling of heat sources, for example, semi-conductor devices housed in a sealed enclosure.

A heat source, for example a semi-conductor device, surrounded by a medium of lower thermal conductivity, may become overheated and malfunction if the heat generated within it when it is operated is not dissipated to the surrounding medium quickly enough. This problem may be overcome by suitably attaching to a heat source a body of larger surface area than the heat source and of a material of higher thermal conductivity than the surrounding medium. Such attachments are known as heatsinks.

Since the heatsink is of higher thermal conductivity than the surrounding medium, heat is preferentially transferred from the heat source to the heatsink rather than to the medium, with the result that there is only a small temperature difference between the heat source and the heatsink. Heat is then transferred from the large surface area of the heatsink to the surrounding medium. For the heatsink to operate efficiently, any temperature difference within the heatsink must be significantly less than that existing between the heatsink and the surrounding medium.

Problems arise when the heat source is in a sealed enclosure, for example a module or box such as an air transport radio casing.

In such an arrangement it is necessary both to transmit heat away from each of the heat sources in the enclosure and at the same time to transmit heat away from the enclosure.

It will be appreciated that in a sealed enclosure there is little scope for removing the heat generated by any heat source directly, for example by convection through the surrounding medium. Again it is difficult to provide a sufficiently high level of heat dissipation to maintain the enclosure at a temperature ensuring correct operation of the devices.

An object of the present invention is to provide apparatus for cooling heat sources in sealed enclosures.

In meeting the object of the invention there is provided an arrangement for cooling one or more heat sources housed in a sealed enclosure, in which the or each heat source is mounted on and in intimate thermal contact with a thermally conductive support member thermally coupled to a wall or walls of the enclosure, and means for cooling the said wall or walls the arrangement being such that heat generated by the or each heat source is transmitted to the wall or walls and removed therefrom by said cooling means. In a preferred alternative, the thermally conductive support members are thermally coupled to said wall or walls by one or more heat pipes.

As is well known in the art, a heat pipe comprises a sealed tube containing a volatile material and a "wick" in the form of a tube lining. One area of the tube "the collector", is arranged to receive heat so that the volatile liquid in that area evaporates, and another area of the tube, "the condenser", is arranged to be cooled so that the vapour there condenses. Thus vapour passes from the collector to the condenser of the heat pipe carrying heat as latent heat. Liquid is recirculated from the condenser to the collector by capillary action in the wick. Gravity aids this capillary action when the heated end is lower than the cool end and opposes

this capillary action when the heat pipe is the opposite way up.

Preferred forms of the invention provide that components generating more heat than others are clamped directly to said wall or walls of the enclosure in which they are housed.

In accordance with other features of the invention the means for cooling the said wall of the enclosure may comprise a cooler element formed from a body of good thermal conductivity in intimate thermal contact with the said wall and through channels in which a fluid coolant is passed, alternatively the wall may be cooled by means of a finned heat sink placed in intimate thermal contact therewith.

As yet another alternative we envisage that the means for cooling the enclosure may be formed wholly or partly at the racking or other supporting frame on which the enclosure is mounted.

The thermal contact between said cooler element and said wall may be improved by heat pipes extending transversely of that surface of said wall abutting the element.

The invention will be more readily understood from the following description made with reference to the accompanying drawings which illustrate diagrammatically and by way of example, various embodiments of the invention and in which:-

Figure 1 is a diagrammatic outline of a form of an arrangement according to the invention;

Figure 2 is a partial perspective view of part of an arrangement embodying the invention;

Figure 3 is a sectional side elevation of a further embodiment of the invention;

Figure 4 is a partial perspective view of another embodiment of the invention;

Figure 5 illustrates in Figures 5A, 5B and 5C respectively three different forms of part of the embodiment shown in Figure 4; and

Figures 6 and 7 are exploded perspective views of parts of arrangements for removing heat from an assembly according to the invention.

With reference to Figure 1 there is shown at 10 a sealed enclosure housing a number of electronic components 11 which together form an electronic circuit and each of which, in operation, generate heat.

Each of the components 11 is thermally connected by thermally conductive support members 12 to one wall 13 of the enclosure. The members 12 may comprise, for example shelves, plates or rods of high thermal conductivity comprising metal or ceramic members or heat pipes.

The wall 13 may comprise a front or rear wall of the enclosure. If the wall is a back wall of the enclosure it may releasably be attached to a heat removing device to be described later.

In Figure 2 there is shown an embodiment of the invention in which the semi-conductor devices 11 are fixed by means of clamps or screws or other suitable means, to thermally conductive metal shelves 12 which in turn are fixed to a rear wall 13 of the enclosure. In this way the shelves 12 which are of higher thermal conductivity than the atmosphere within the enclosure act as receivers for the heat generated in operation by the devices 11 and transmit this heat to the rear wall 13 of the enclosure.

A way of increasing the thermal connection between the elements 11 and wall 13 is shown in Figure 3 and comprises a fan 16 operable to blow air within the enclosure across the elements 11 towards the end wall 13. As shown in Figure 3 the end wall 13 may be provided with fins 17 which substantially increase the area of contact between the air streams generated by the fan 16 and the wall of the enclosure.

In Figure 4 there is shown a preferred arrangement embodying the invention in which the heat generated by the elements 11 is transmitted to the end wall 13 by means of heat pipes 14 on which the elements are supported within the enclosure.

The heat pipes 14 may directly support the elements 11 to which they may be attached for example by clamping, gluing or any other suitable means providing good thermal contact or may, as shown, be attached to shelves or trays 15 on which the elements 11 stand.

The heat pipes 14 shown in Figure 4 beneath the or each tray or shelf may be connected thereto in any suitable manner, for example as shown in Figure 5A a heat pipe 14 may be connected to a shelf or tray 15 by means of semi-circular clamps 16 fixed to the tray with screws or bolts 17A. As shown in Figure 5B the heat pipe may be connected to a shelf comprising a pair of members 15' and 15" each of which is shaped to conform to part of the surface of the heat pipe such that the heat pipe is sandwiched therebetween, the halves 15' and 15" of the shelf being clamped together by screws or bolts 17A. Again in the arrangement in Figure 5C a heat pipe 14 is rigidly attached to a shelf or tray 15 by means of brazing, welding or any other suitable means such as shown at 18.

It will be appreciated that with the above described arrangements there is provided a good thermal contact between each of the elements 11 housed in the enclosure and an end wall of the enclosure. In practice the end wall 13 of the enclosure 10 may comprise a front wall of the module and be provided with a cooler element such as, for example, a fin or other arrangement which may be shaped as a handle for the enclosure.

If the wall 13 is a rear wall of the enclosure the rear wall is clamped or otherwise brought

into close contact with a cooler element through which a coolant fluid may be passed. Such an arrangement is shown in Figure 6 in which a cooler 21 is provided for clamping to the rear wall 13 of the enclosure 10. The cooler 21 comprises a metallic body of good thermal conductivity and has two passageways 22 formed in it through which water or any other suitable coolant fluid may be passed to carry heat away from the enclosure.

To enable good thermal contact to be made between the end wall of the enclosure and the cooler element one or more heat pipes may be provided as shown at 23.

The heat pipes provided on the rear wall of the enclosure provide that the heat transmitted to that wall, from the elements 11 within the enclosure, is evenly distributed over the whole area of the rear wall.

By providing semi-circular grooves in the wall 13 of the enclosure; and by laying a circular cross-section heat pipe in these grooves problems of providing adequate degrees of flatness between the cooler 21 and the wall 13 is overcome and for a given thermal resistance at the interface the contact pressure may be substantially reduced.

An alternative to the arrangement of Figure 6 is shown in Figure 7 in which the cooler 21 is replaced by a heat sink body 25 formed with a plurality of vertically extending fins 26 as shown. Heat pipes 27 are again used to improve thermal transfer between the end wall 13 and the heat sink 25.

As a further alternative we suggest that the rear wall 13 may be cooled by contact with part of the racking in which the enclosure is mounted.

It will be seen that it is within the scope of the present invention for the various alternative arrangements shown in the figures to be combined to substantially increase the rate of heat transfer away from each of the components housed in a sealed enclosure, for example the heat pipes enclosed in Figure 4 may be combined with the arrangement shown in Figure 2 such that, for example, the heat pipes extend wholly or partially into or along the or each shelf or shelves on which the components 11 are mounted. Again it may be provided in an arrangement according to the invention that the additional elements 11 which are likely to produce the more heat than other elements whilst in operation are clamped directly to the wall of the enclosure which is used as the heat dissipation surface.

WHAT WE CLAIM IS:-

1. An arrangement for cooling one or more heat sources housed in a sealed enclosure, in which the or each heat source is mounted on and in intimate thermal contact with a thermally conductive support member thermally coupled to a wall or walls of the enclosure, and means for cooling the said wall or walls the arrangement being such that heat generated by the or each heat source is transmitted to the wall or walls and removed therefrom by said cooling means.

2. An arrangement according to Claim 1 and including a fan within the enclosure and operable to blow air over the or each heat source toward the or each said wall by a fan.

3. An arrangement according to Claim 1 or Claim 2, wherein said thermally conductive support member is of metal.

4. An arrangement according to any one of Claims 1, 2 and 3, wherein said support member is thermally coupled to said wall or walls by one or more heat pipes.

5. An arrangement according to any one of Claims 1 to 3, wherein said support members comprise heat pipes ends of which engage said wall or walls.

6. An arrangement according to any one of Claims 1 to 5, and including one or more additional said heat sources clamped directly onto the said wall or walls.

7. An arrangement according to any one of Claims 1 to 6, wherein the cooling means comprises a cooler element of good thermal conductivity arranged in intimate thermal contact with the or each said wall and provided with passageways through which a coolant fluid is passed in use.

8. An arrangement according to any of Claims 1 to 6, wherein the cooling means comprises a finned heat sink positioned in intimate thermal contact the or each said wall.

9. An arrangement according to any one of Claims 1 to 6, wherein the said cooling means comprises racking in which the enclosure is mounted.

10. An arrangement according to any one of Claims 1 to 9, wherein one or more heat pipes are provided to extend transversely of the or each said wall of the enclosure in intimate thermal contact with said wall and with said cooling means to increase the rate of heat transfer away from the or each said wall.

11. An arrangement according to any one of the preceding claims wherein the heat sources comprise semi-conductive devices together forming an electronic circuit.

12. An arrangement for cooling one or more heat sources housed in a sealed enclosure substantially as hereinbefore described with reference to the accompanying drawings.

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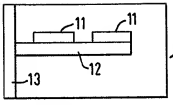

FIG. 1

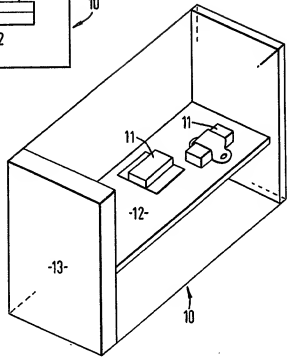

FIG. 2

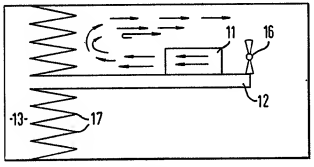

FIG. 3

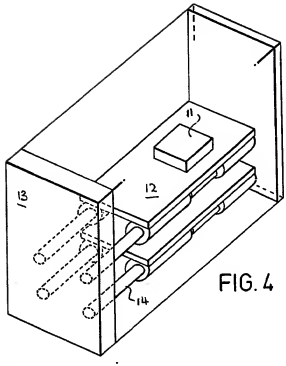

FIG. 4

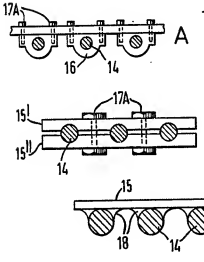

FIG. 5

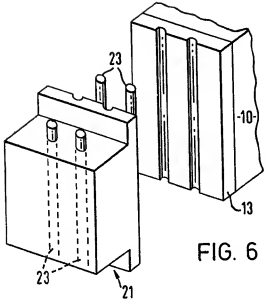

FIG. 6

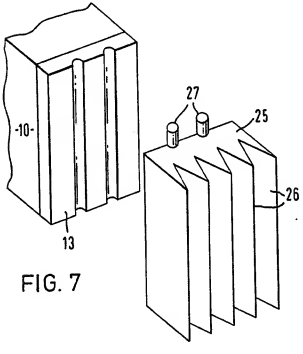

FIG. 7